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GB 2318395 A

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UK CL (Edition V) **F2D**
INT CL[7] **F16H**
Other: **ONLINE: EPODOC, JAPIO, WPI**

(54) Abstract Title: **Shift mechanism having a rotating drum**

(57) A shift mechanism 100, for a twin clutch transmission system, comprises a plurality of shift rails 92, 94, 96, 98, which control synchromesh units of a multi-ratio gearbox, and a drum 102 that engages via an annular groove 110 with abutments 112 mounted on the shift rails. A gear may be selected by energizing electric motor 140 to move a control shaft 106 so that forked abutment means 122 is located centrally in axial slot 120. The drum 102 and control shaft 106 may than be rotated, via a pinion 132 and gear 134, by motor 130, until the abutment 122 is aligned axially with one of the abutment 112 on the shift rail associated with the gear to be engaged. Motor 140 may then be energized to move, via a leadscrew 142 and nut 144, the control shaft 106 in the appropriate axial direction to engage a gear.

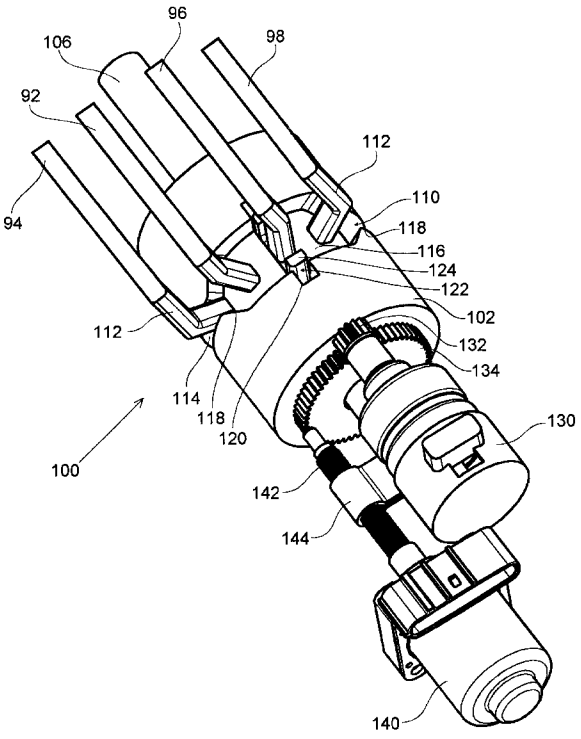

Fig. 2

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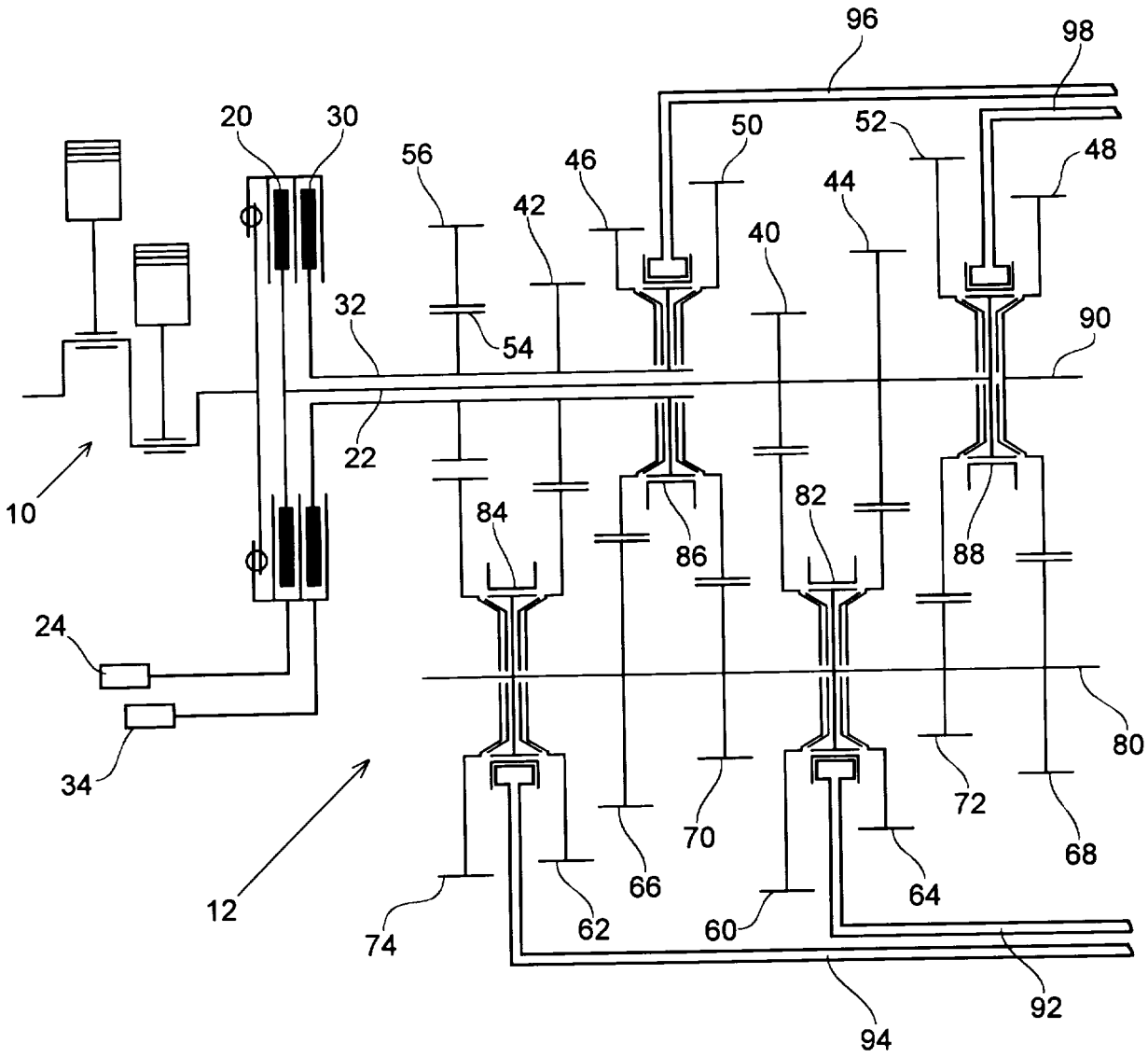
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94

Fig. 1

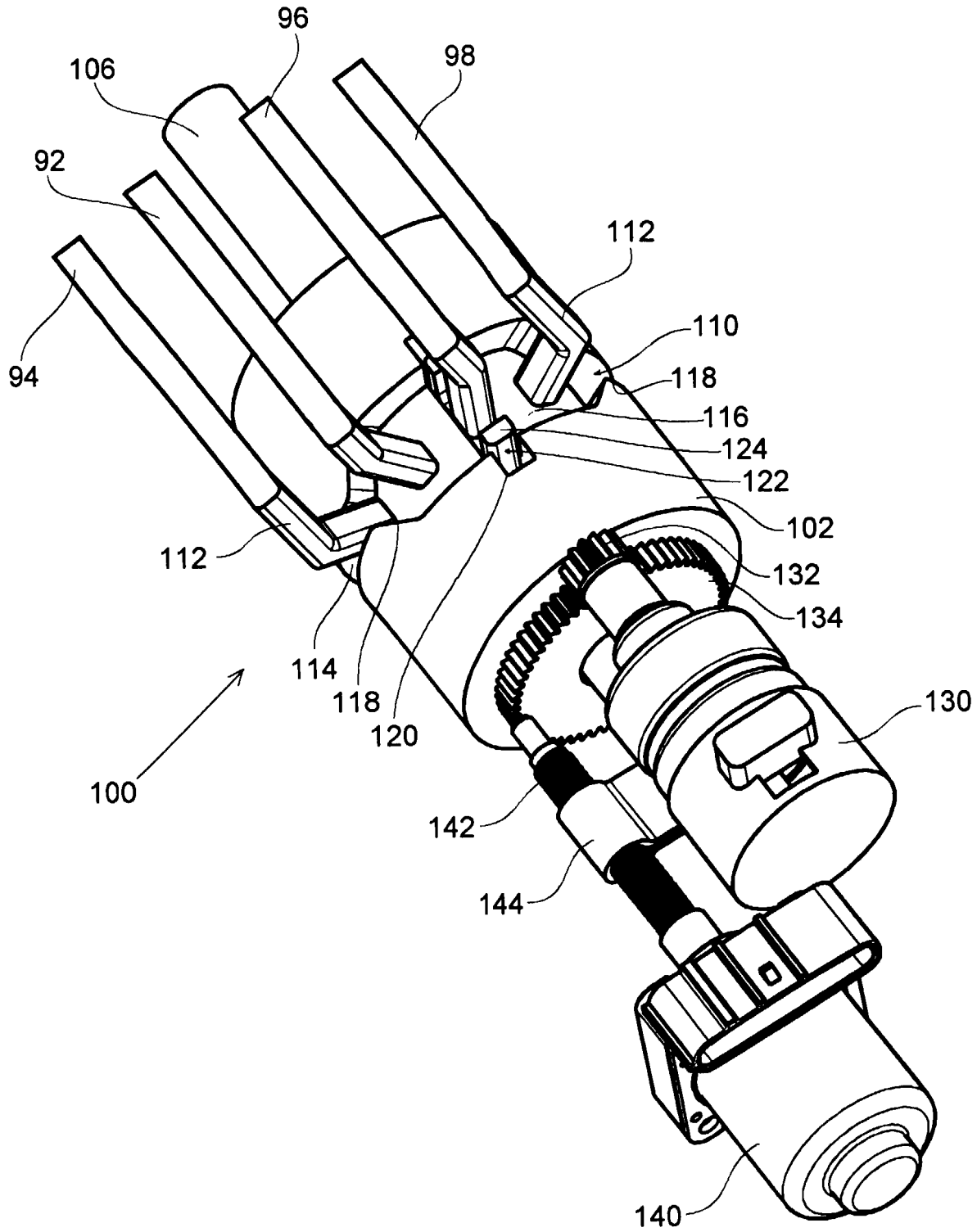
96
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Fig. 2

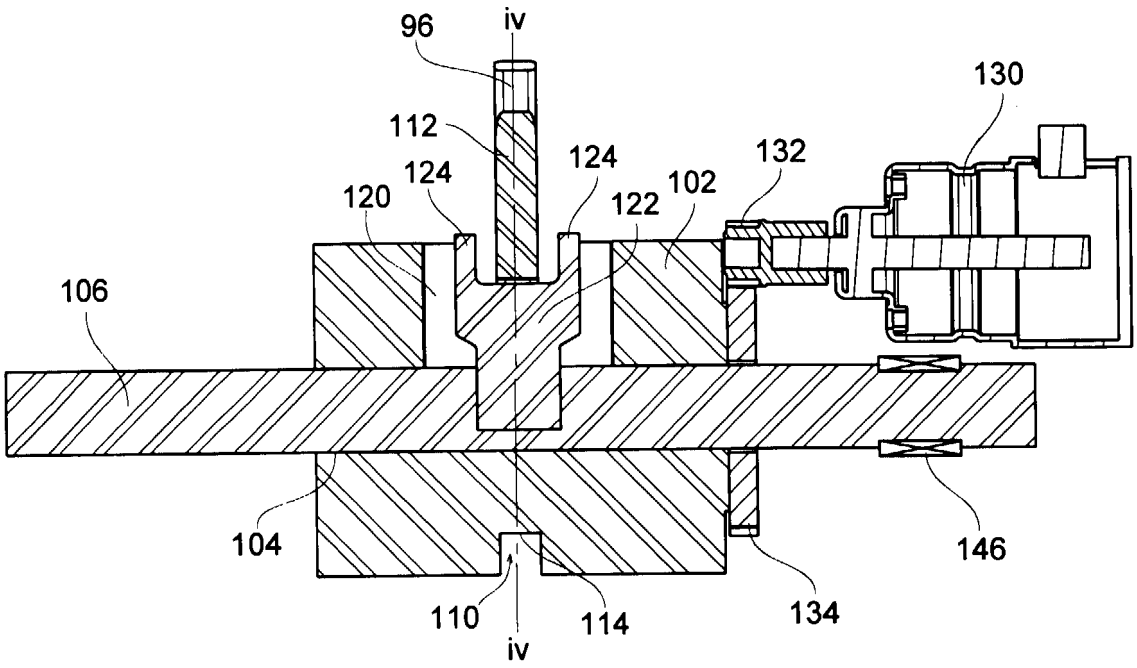
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Fig. 3

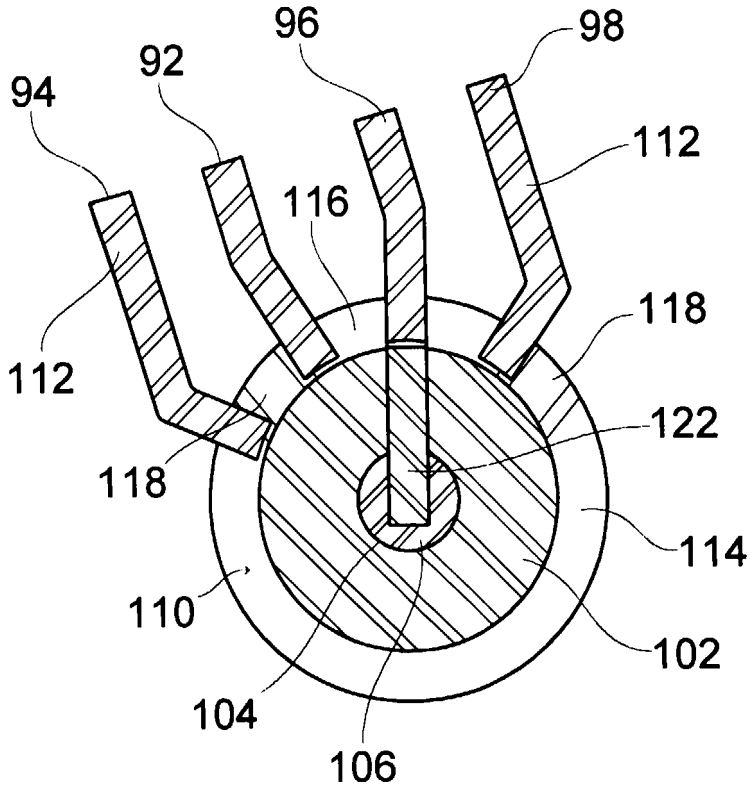
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Fig. 4

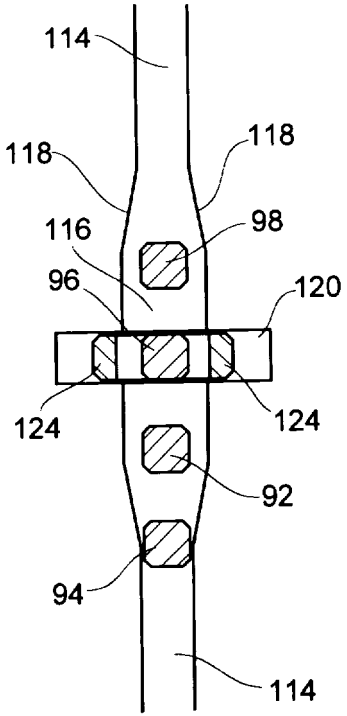

Fig. 5a

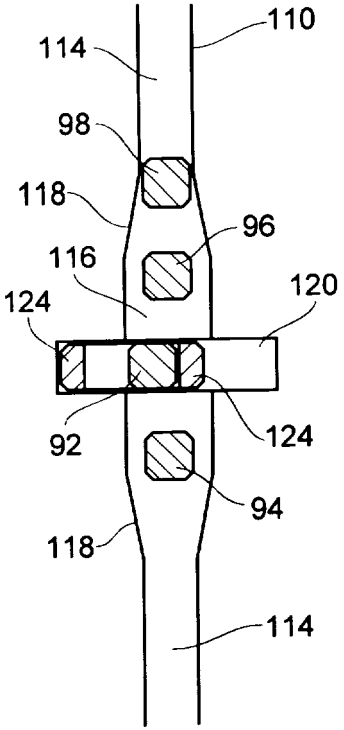

Fig. 5b

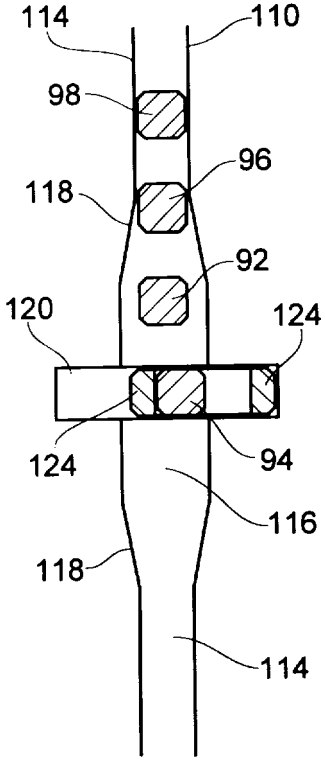

Fig. 5c

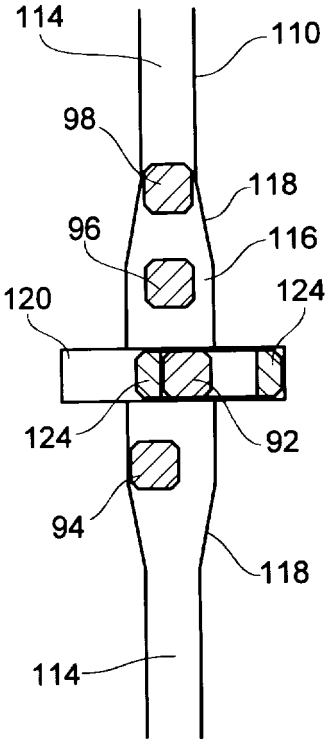

Fig. 5d

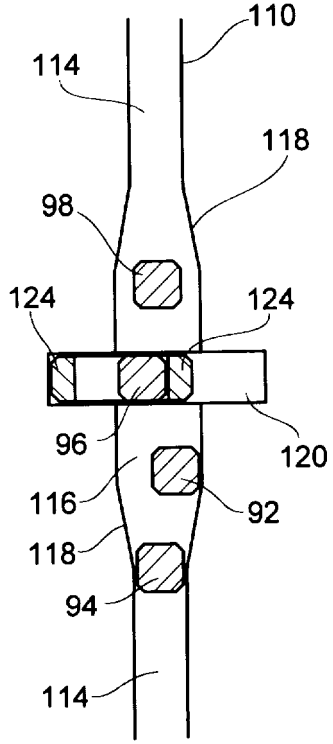

Fig. 5e

GEAR SHIFT MECHANISMS

The present invention relates to gear shift mechanisms and in particular gear shift mechanisms for use with automated, twin clutch transmission systems of, for example, the type disclosed in GB0028310.1; whose content is expressly incorporated in the disclosure content of the present application.

With twin clutch transmission systems of this type, a first clutch, when engaged transmits torque between the output shaft of an engine and a first input shaft of the gear box and a second clutch, when engaged, transmits power between the output shaft of the engine and a second input shaft of the gear box. The first and second input shafts are mounted coaxially of one another.

A first set of gears are mounted for rotation with the first input shaft and a second set of gears are mounted for rotation with the second input shaft, the first and second sets of gears rotatably mounted on one or more lay shafts. The first and second sets of gears and the gear with which they mesh, are arranged to provide different ratios. Typically, the first set of gears which are associated with the first clutch provide first, third, fifth and seventh gear ratios and the second set of gears associated with the second clutch provide second, fourth and sixth ratios and a reverse ratio.

One of the gears of each pair of meshing gears is mounted on the associated shaft for rotation relative thereto and is selectively rotatably connected to the shaft by means of a synchromesh unit. Each synchromesh unit is positioned between a pair of gears, so that movement of the synchromesh unit axially towards one gear will engage that one gear and movement axially towards the other gear will engage that other gear. Movement of the synchromesh units is controlled by means of shift rails, a yoke on each of the shift rails engaging a peripheral groove in the synchromesh unit.

With transmission systems of this type, the clutch controlling the engaged gear would be engaged, while the other clutch is disengaged. To change gear, a gear

With transmission systems of this type, the clutch controlling the engaged gear would be engaged, while the other clutch is disengaged. To change gear, a gear associated with the other clutch may be engaged by appropriate manipulation of the synchromesh unit associated with that gear, while the current gear remains engaged. The gear change is then effected by simultaneously disengaging one clutch and engaging the other clutch, in order to achieve a smooth transfer of torque.

On the next change, it is necessary to control the synchromesh units to disengage the previously engaged gear and to engage the target gear.

If a conventional shift mechanism is used, by which only a single synchromesh unit may be controlled at a time, this will adversely affect the speed of the change. This problem may be overcome by utilising separate actuators for each of the shift rails, as proposed in GB0028310.1. This however will require the multiplication of actuators and control equipment, and will add considerably to the cost of the system. Furthermore, for transmission systems with larger numbers of ratios, there may be severe problems in accommodating the numerous actuators in the space available.

In accordance with one aspect of the present invention a shift mechanism for a twin clutch transmission system comprises;

a plurality of shift rails mounted parallel to one another, each shift rail being adapted to control a synchromesh unit of a multi-ratio gear box;

a drum mounted for rotation about an axis parallel to an axis of the shift rails, the drum being mounted for rotation on a control shaft;

the drum having an annular groove, an abutment on each of the shift rails extending into the annular groove, the abutment of the shift rails being disposed around the groove at angularly spaced locations;

the annular groove in the drum having a first portion with an axial width that is a close clearance fit with the abutments on the shift rails and a second portion, the width of which is sufficient to permit axial movement of the abutment on the

shift rails between a first position in which a first gear associated with the synchromesh unit controlled by the shift rail is engaged and a second position in which a second gear associated with the synchromesh unit controlled by the shift rail is engaged, ramps being provided in the walls of the groove, between the first and second portions;

an axial slot being provided in the drum, said axial slot extending beyond the walls of the annular groove centrally of the second portion thereof;

abutment means being provided on the control shaft, said abutment means extending through the axial slot;

means for rotating the drum and control shaft to bring the abutment means on the control shaft into axial alignment with the abutment on one of the shift rails; and

means for moving the control shaft axially in order to move the abutment on the aligned shift rail to one wall of the second portion of the annular groove, in order to engage a gear associated therewith.

In this manner, by rotation of the drum and axial movement of the control shaft, two actuators, a rotary actuator and a linear actuator may be used to control all the synchromesh units of the gear box. The second portion of the annular groove is arranged such that rotation of the drum to engage a new target gear, will automatically disengage the previously engaged gear, the abutment thereof being moved back to a neutral position, by the ramp between the second and first portions of the annular groove. At the same time, the currently engaged gear remains in the second portion of the annular groove. Furthermore, all the gears may be forced to the neutral position by rotating the drum, so that all of the abutments on the shift rails are accommodated in the first portion of the annular groove.

The abutments on the shift rails and the abutment means on the control shaft must be capable of moving the shift rails in either direction. A forked abutment must consequently be provided on either the shift rails or the control shaft, so that

the abutment on the other will be located between the forked abutment thereby permitting movement in both directions.

The invention is now described, by way of example only, with reference to the accompanying drawings, in which:-

Figure 1 is a diagrammatic illustration of a twin clutch transmission system;

Figure 2 is an isometric view of a gear shift mechanism in accordance with the present invention;

Figure 3 is a sectional side elevation of the shift mechanism illustrated in figure 2;

Figure 4 is a section along the line iv-iv of figure 3; and

Figures 5a to 5e show projections of a track on a drum of the mechanism illustrated in figures 2 to 4, illustrating shifts into a 1st gear and changes from 1st gear - 2nd gear - 3rd gear - 4th gear.

In the transmission system illustrated in figure 1 a first active clutch 20, when engaged, transmits torque between the output shaft of engine 10 and a first input shaft 22 of the gearbox 12 and a second active clutch 30, when engaged, transmits torque between the output shaft of engine 10 and a second input shaft 32 of the gearbox 12. Input shaft 32 extends coaxially of input shaft 22.

Engagement of clutches 20 and 30 is controlled independently by clutch slave cylinders 24 and 34 respectively, hydraulic pressure being applied to the slave cylinders 24,34 to engage the clutches 20 and 30 respectively.

Input shaft 22 has two gears 40,44 mounted thereon for rotation therewith. Two further gears 48,52 are mounted on input shaft 22 for rotation relative thereto, the gears 48 and 52 being selectively engaged for rotation with input shaft 22 by means of a synchromesh unit 88.

Input shaft 32 has two gears 42,54 mounted thereon for rotation therewith. Two further gears 46,50 are mounted on input shaft 32 for rotation relative thereto, the gears 46 and 50 being selectively engaged for rotation with input shaft 32 by means of a synchromesh unit 86.

Gears 40,42,44,46,48,50 and 52 mesh with gears 60,62,64,66,68,70 and 72 respectively and gear 54 meshes with gear 74, via an intermediate gear 56. The gears 60,62,64,66,68,70,72 and 74 are mounted on a lay shaft 80, which is mounted parallel to but spaced from input shafts 22 and 32. Gears 66,68,70 and 72 are mounted on lay shaft 80 of rotation therewith, while gears 60,62,64 and 74 are mounted on lay shaft 80 for rotation relative thereto, gears 60 and 64 being selectively engaged for rotation with lay shaft 80 by means of a synchromesh unit 82 and gears 62 and 74 being selectively engaged for rotation with lay shaft 80 by means of a synchromesh unit 84.

The gears 40 and 60 are sized to provide a first gear ratio; gears 42 and 62 a second gear ratio; gears 44 and 64 a third gear ratio; gears 46 and 66 a fourth gear ratio; gears 50 and 70 a sixth gear ratio and gears 52 and 72 a seventh gear ratio; while intermediate gear 56 reverses the direction of rotation so that gears 54 and 74 provide a reverse gear ratio.

The lay shaft 80 is drivingly connected to an output shaft 90 from the gearbox12, via gears 68 and 48.

The synchromesh units 82,84,86,88 are controlled by individual shift rails 92,94,96,98 respectively, by which they may be moved axially of the respective input shaft 22,32 or lay shaft 80. Whereby synchromesh unit 82 may be moved to the left, as illustrated in figure 1, to engage gear 60 with layshaft 80, or the right to engage gear 64 with lay shaft 80; synchromesh unit 84 may be moved to the left to engage gear 74 with layshaft 80, or the right to engage gear 62 with lay shaft 80; synchromesh unit 86 may be moved to the left to engage gear 46 with input shaft 32, or the right to engage gear 50 with input shaft 32; and synchromesh unit 88 may be moved to the left to engage gear 52 with input shaft 22, or the right engage gear 48 with input shaft 22 thereby coupling the input shaft 32 directly with the output shaft 90 to provide a direct drive, fifth gear ratio.

Clutch 20 may consequently be used to selectively engage the first, third fifth and seventh ratios by suitable manipulation of shift rails 92 and 98, while clutch 30 may be used to selectively engage the second, fourth, sixth and reverse ratios by suitable manipulation of shift rails 94 and 96. When the transmission is in gear with one of the clutches 20,30 engaged, a gear associated with the disengaged clutch 30,20 may be selected. In order to change gear, the engaged clutch 20,30 is disengaged, the other clutch 30,20 at the same time being engaged, the torque transmitted by the two clutches being balanced to provide a smooth gear change.

The shift rails 92,94,96 and 98 are moved axially by means of an actuator mechanism 100 as illustrated in figures 2 to 4. The shift rails 92,94,96 and 98 are mounted parallel to one another, a yoke (not shown) mounted on each of the shift rails 92,94,96,98, towards the end thereof remote from the actuator mechanism 100, engaging a circumferential groove in each of the synchromesh units 82,84,86,88 respectively.

The actuator mechanism 100 comprises a drum 102 which is mounted for rotation about an axis parallel to the axis of the shift rails 92,94,96,98. The drum 102 has an axial bore 104, a control shaft 106 being mounted coaxially of the drum 102, the control shaft 106 extending through the bore 104. The control shaft 106 is mounted for movement axially of the drum 102 and rotationally with the drum 102.

The drum 102 has an annular groove 110 in its external diameter. An abutment 112 at the end of each of the shift rails 92,94,96,98 extends into the groove 110, the abutments 112 being disposed at angularly spaced locations around the groove 110. The groove 110 has a first circumferentially extending portion 114 which has an axial width which is a close clearance fit with the abutments 112 on the shift rails 92,94,96,98; and a second circumferentially extending portion 116, the width of which is sufficient to permit movement of the shift rails 92,94,96,98, in either direction, to a sufficient extent to permit engagement of the gears 60,64;74,62;46,50;52,48 associated with the respective shift rail 92,94,96,98. The first portion 114 of groove 110 and abutments 112 on shift rails 92,94,96,98 are positioned such that when abutments 112 engage in portion 114, the synchromesh unit will be in a neutral position, in which neither of the gears 60,64;74,62;46,50; 52,48 associated therewith

are engaged with the associated shafts 22,32,80. The walls of the groove 110, between the first and second sections 114,116, define ramp formations 118.

An axial slot 120 is provided in the drum 102, the axial slot 120 extending radially from the bore 104 to the external diameter of drum 102, centrally of the second portion 116 of groove 110 and axially beyond the walls of groove 110 defining the second portion 116 thereof.

A forked abutment means 122 is mounted on control shaft 106, for axial movement therewith. The abutment means extends through slot 120. Parallel branches 124 of the forked abutment means 122 are spaced to permit the abutments 112 to be located therebetween, so that they may be moved axially in either direction, by axial movement of the control shaft 106, the axial extent of the slot 120 being sufficient to permit axial movement of the abutments 112 to the axial extremities of the second portion 116 of the groove 110.

A first electric motor 130 is drivingly connected to a pinion 132, which meshes with a gear 134 formed on the end face of drum102, for rotation of the drum 102 and control shaft 106. A second electric motor 140 drives a leadscrew 142, the leadscrew 142 being parallel to but offset from the control shaft 106. A leadscrew nut 144 engages the thread on the leadscrew 142, the leadscrew nut 144 being attached to the control shaft 106 by means of a bearing 146 which will permit rotation of the control shaft 106 but is fixed axially with respect the control shaft 106. Rotation of the leadscrew 142 by motor 140 will consequently cause the leadscrew

nut 144, which is restrained from rotating by the control shaft 106, to move axially of the leadscrew 142, thereby causing axial movement of the control shaft 106.

When the gearbox 12 is in neutral, with all four synchromesh units 92,94,96,98 in their neutral positions as illustrated in figure 5a, a gear may be selected by energising electric motor 140 to move the control shaft 106, so that the abutment means 122 is located centrally of the slot 120. The drum 102 and control shaft 106 may then be rotated by motor 130, until the abutment 122 is aligned axially with the abutment 112 on the shift rail 92,94,96,98 associated with the gear to be engaged. Motor 140 may then be energised to move the control shaft 106 in the appropriate axial direction the engage the gear. For example, to engage first gear, the clutch 20 is first disengaged, motor 130 will be energised to rotate the drum 102 and control shaft 106, so that the abutment 122 is aligned with the abutment 112 on shift rail 92. Motor 140 is then energised to move shift rail 92 to the left as illustrated in figure 5b, so that the abutment 112 is moved to the left hand side of portion 116 of groove 110 and gear 60 is engaged for rotation with lay shaft 80. Clutch 20 may then be re-engaged to engage first gear.

To change from first gear to second gear, motor 130 is energised to rotate the drum 102 and control shaft 106, so that the abutment 122 is moved to a position intermediate of the abutments 112 on shift rails 92,94. The motor 140 is then energised to move abutment 122 back to a position centrally of slot 120, while leaving the first gear engaged. Motor 130 is then re-energised to rotate the drum 102 and control shaft 106, to align abutment means 122 with the abutment 112 on shift rail 94. Clutch 30 is

then disengaged and motor 140 energised to move control shaft 106 and shift rail 94 to the right as illustrated in figure 5c, thereby engaging gear 62 for rotation with lay shaft 80. Clutch 30 may then be engaged while clutch 20 is disengaged, to engage second gear.

On a subsequent change from second gear to third gear, motor 130 is energised to bring the abutment means 122 to a position intermediate of the abutments 112 on shift rails 92,94. The abutment means is then moved to the left hand side of slot 120 by motor 140 and rotated by motor 130, to bring abutment means 122 back into alignment with the abutment means 112 on shift rail 92. Motor 140 may then be energised to move shift rail 92 to the right hand side of groove 110 as illustrated in figure 5d, so that gear 60 is disengaged from shaft 80 and gear 64 is engaged with shaft 80. Clutch 30 may then be disengaged and clutch 20 engaged to change from second gear to third gear.

To change from third gear to fourth, the abutment means 122 is rotated to a position intermediate of the abutments 112, moved axially to a central position, and rotated into alignment with abutment 112 on shift rail 96, in similar manner to that disclosed above. However, as the abutment 122 moves from alignment with abutment 112 on shift rail 92 to alignment with abutment 112 on shift rail 96, the abutment 112 on shift rail 94 engages ramp formation 118 and is moved to its neutral position, so that shift rail 94 disengages gear 62 from lay shaft 80. The motor 140 may then be energised to move abutment means 122 to the left as illustrated in figure 5e, engaging gear 66 for rotation with shaft 22. Engagement of clutch 30 and disengagement of clutch 20 will then change from third gear to fourth gear.

Other gear changes may be achieved in similar manner.

Moreover all of the shift rails 92,94,96,98 may be forced to the neutral position by rotation of the drum 102, so that all of the abutments 112 are located in the first section 114 of groove 110.

Various modifications may be made without departing from the invention, for example, the abutments 112 on the shift rails 92,94,96,98 may be forked and the abutment means 122 on the control shaft 106 adapted to engage between the branches of the forked abutments 112, to permit movement of the shift rails 92,94,96,98 in either direction.

Other means my be used for rotation if the drum 102 and control shaft 106 and for moving the control shaft 106 axially, for example other electro-mechanical mechanisms, pneumatic or hydraulic means. The leadscrew nut may be connected indirectly to the control shaft 106, for example to include elasticity in the drive. Gearing may also be included in the drives between motor 130and pinion 132 and/or between motor 140and leadscrew 142. Moreover during shift from one gear to another both motors may be operated simultaneously, so that the intermediate position can be achieved in a scrolling motion rather than discrete movements of the drum and control shaft.

While in the above embodiment, the clutches 20,30 are controlled hydraulically, the may be controlled by other means, for example pneumatic or electro-mechanical actuators.

The number of gear ratios, synchromesh units, and shift rails in the gear box and the arrangement thereof may also be varied.

The patent claims submitted with the application are proposed formulations without prejudice to the achievement of further patent protection. The applicant reserves the right to submit claims for further combinations of characteristics, previously only disclosed in the description and/or drawings.

References back used in sub-claims refer to the further development of the subject of the main claim by the characteristics of the respective sub-claim; they are not to be understood as a waiver with regard to achieving independent item protection for the combination of characteristics in the related sub-claims.

Since the subject of the sub-claims can form separate and independent inventions with reference to the prior art on the priority date, the applicant reserves the right to make them the subject of independent claims or of division declarations. Furthermore, they may also contain independent inventions, which demonstrate a design, which is independent of one of the objects of the preceding sub-claims.

The embodiments are not to be considered a restriction of the invention. Rather, a wide range of amendments and modifications is possible within the scope of the current disclosure, especially those variations, elements and combinations and/or materials which, for example, the expert can learn by combining individual ones together with those in the general description and embodiments in addition to characteristics and/or elements or process stages described in the claims and contained in the drawings with the aim of solving a task thus leading to a new object or new process stages or sequences of process stages via combinable characteristics, even where they concern manufacturing, testing and work processes.

Claims

1. A shift mechanism (100) for a twin clutch transmission system comprising;

a plurality of shift rails (92,94,96,98) mounted parallel to one another, each shift rail (92,94,96,98) being adapted to control a synchromesh unit (82,84, 86,88) of a multi-ratio gear box (12); characterised in that

a drum (102) is mounted for rotation about an axis parallel to an axis of the shift rails (92,94,96,98), the drum (102) being mounted for rotation about a control shaft (106);

the drum (102) having an annular groove (110), an abutment (112) on each of the shift rails (92,94,96,98) extending into the annular groove (110), the abutments (112) of the shift rails (92,94,96,98) being disposed around the groove (110) at angularly spaced locations;

the annular groove (110) in the drum (112) having a first portion (114) with an axial width that is a close clearance fit with the abutments (112) on the shift rails (92,94,96,98) and a second portion (116), the width of which is sufficient to permit axial movement of the abutment (112) on the shift rails (92,94,96,98) between a first position in which a first gear (60,64;74,62;46,50;52,48) associated with the synchromesh unit (82,84,86,88) controlled by the shift rail (92,94,96,98) is engaged and a second position in which a second gear (64,60; 62,74;50,46; 48,52) associated with the synchromesh unit (82,84,86,88) controlled by the shift rail (92,94,96,98) is engaged, ramps (118) being provided in the walls of the groove, between the first and second portions (114,116);

an axial slot (120) being provided in the drum (102), said axial slot (120) extending beyond the walls of the annular groove (110) centrally of the second portion (116) thereof;

abutment means (122) being provided on the control shaft (106), said abutment means (122) extending through the axial slot (120);

means (130,132,134) for rotating the drum (102) and control shaft (106) to bring the abutment means (122) on the control shaft (106) into axial alignment with the abutment (112) on one of the shift rails (92,94,96,98); and

means (140,142,144) for moving the control shaft (106) axially in order to move the abutment (112) on the aligned shift rail (92,94,96,98) to one wall of the second portion (116) of the annular groove (110), in order to engage a gear associated therewith.

2. A shift mechanism (100) according to claim 1 characterised in that the abutment means (122) on the control shaft (106) is forked, having a pair of branches (124) between which the abutments (112) on the shift rails (92,94,96,98) may be located, permitting movement of the shift rails (92,94,96,98) in opposite axial directions, in response to axial movement of the control shaft (106).

3. A shift mechanism (100) according to claim 1 characterised in that the abutments (112) on the shift rails (92,94,96,98) are forked, having a pair of branches between which the abutments means (122) on the control shaft (106) may be located, permitting movement of the shift rails (92,94,96,98) in opposite axial directions, in response to axial movement of the control shaft (106).

4. A shift mechanism (100) according to any one of the preceding claims characterised in that the drum (102) and control shaft (106) are rotated by means of a first electric motor (130).

5. A shift mechanism (100) according to claim 4 characterised in that the first electric motor (130) is drivingly connected to the drum (102) by means of a pinion (132) which meshes with a gear (134) mounted on the drum (102).

6. A shift mechanism (100) according to any one of the preceding claims characterised in that the control shaft (106) is moved axially by means of a second electric motor (140).

7. A shift mechanism (100) according to claim 6 characterised in that the second electric motor (140) drives the control shaft (106) by means of a leadscrew mechanism (142,144).

8. A shift mechanism (100) according to claim 7 characterised in that an output shaft of the second electric motor (140) is drivingly connected to a leadscrew (142), a leadscrew nut (144) engages the leadscrew (142), the leadscrew nut (144) being drivingly connected to the control shaft (106), in a manner which is fixed axially with respect to the control shaft 106 but will permit rotation of the control shaft (106) relative to the leadscrew nut (144).

9. A shift mechanism (100) for a twin clutch transmission system, substantially as described herein with reference to and as shown in figures 1 to 5 of the accompanying drawings.

INVESTOR IN PEOPLE

Application No: GB 0224334.3 17 **Examiner:** Mike Mckinney
Claims searched: 1 to 9 **Date of search:** 24 March 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance
A		GB 2318395 A (MANNESMANN SACHS AG)

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category.	P	Document published on or after the declared priority date but before the filing date of this invention.
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application.

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[V]:

F2D

Worldwide search of patent documents classified in the following areas of the IPC[7]:

F16H

The following online and other databases have been used in the preparation of this search report:

EPODOC, JAPIO, WPI